

TEST REPORT

47 Cfr Ch. 1 (10-1-99 Edition).

**CUSTOMER AND
MANUFACTURER:**

Saab Marine Electronics AB
Box 13045
SE-402 51 Göteborg
Sweden

**EQUIPMENT UNDER
TEST (EUT):**

Radar Level Gauge. Model Saab Loopradar, s/n 010.

TEST SPEC.:

47 Cfr Ch. 1 (10-1-99 Edition):
1. Part 15, Subpart B, Class B, Digital Devices.
§ 15.107. Conducted emission
§ 15.109. Radiated emission
2. Part 15, Subpart C, Field Disturbance Sensor.
§ 15.207. Conducted emission
§ 15.209. Radiated emission

DATE OF TEST:

March 14 - 15, 2000

TEST SITE:

Svenska EMC Lab AB, Karlskrona, Sweden.
FCC List No 31040/SIT 1300F2.

TEST PERSONNEL:

Svenska EMC Lab AB: Bo Gidlöw.
Saab Marine Electronics AB: Per Karlsson.

TEST RESULT:

The EUT (Equipment Under Test) did pass the above mentioned test.

Karlskrona March 28, 2000



Hans Östergren
Manager Svenska EMC Lab AB

DATE OF RECEIPT: March 14, 2000

CONDITION OF EUT: No remarks. Operates as intended.

DESCRIPTION OF THE EUT:

The EUT is a Radar Tank Gauge used in industrial environments. The used radar frequency is fixed to 6.22 GHz. The output power is below 1 mW. To control the radar digital circuits are integrated in the same enclosure as the radar transmitter-receiver. A display and switches for the operation is built-in. Four different types of antennas were delivered together with the EUT:

1. Horn Antenna, 8"
2. Horn Antenna, 6"
3. Horn Antenna, 4"
4. Rod Antenna

The radar is designed for installation in plastic tanks or to operate in open environment. The test sample was measured without any additional tank. The EUT input power range is 18 – 36 VDC. Output signal is 4 – 20 mA in the power cable. This signal could be detected with a simple passive peripheral unit.

CALIBRATION DECLARATION:

The test equipment is calibrated as the calibration information in the Test Equipment list. Before starting of the tests the check points in the applicable Checklists were confirmed.

ESTIMATED UNCERTAINTY:

Expanded uncertainty (k = 2), Conducted Emission, 0.45 – 30 MHz:	± 1.2 dBµV
Expanded uncertainty (k = 2), Field Strength, emission 9 kHz – 1000 MHz:	± 2.4 dBµV/m
Expanded uncertainty (k = 2), Field Strength, emission 1 to 40 GHz:	± 3 dBµV/m
Frequency, 0.45 – 1000 MHz:	± 10 Hz
Frequency, 1 – 40 GHz:	± 100 kHz
Temperature:	± 1 °C
Humidity:	± 5 %

The uncertainties are for a confidence level of not less than 95 %.

TEST EQUIPMENT:

<u>Type/Manufacturer/Bandwidth</u>	<u>s/n</u>	<u>Calibration information</u>	
		<u>Date</u>	<u>Interval</u>
For emission test up to 1 GHz:			
EMI Test System, Monitor EZM, Rohde & Schwarz EP-6, 20 Hz - 1300 MHz	860157/014	9907	12 months

TEST EQUIPMENT (CONTINUED):

<u>Type/Manufacturer/Bandwidth</u>	<u>s/n</u>	<u>Calibration information</u>	
		<u>Date</u>	<u>Interval</u>
Test Receiver, Rohde & Schwarz ESH-3, 9 kHz - 30 MHz	894979/013	9907	12 months
Test Receiver, Rohde & Schwarz ESVP, 20 - 1300 MHz	893497/006	9907	12 months
Pulse Limiter Rohde & Schwarz ESH3-Z2 DC - 30 MHz	357881052	9907	12 months
Plotter, Rohde & Schwarz DOP 2	893117/0008	9907	12 months
LISN 50 OHM/50 uH, Schwarzbeck NSLK8126, 10 kHz - 30 MHz, 25 A	93-84105	9907	12 months
Software, Rohde & Schwarz EZM K-1	K 1 V 1.06	9908	12 months
Active Loop Antenna, EMCO, 6502 9 kHz - 30 MHz	1057	9709	36 months
Biconical Antenna, Schwarzbeck BBA9106 30 - 300 MHz	93-92196.1	9907	12 months
Log-periodic Antenna, Schwarzbeck UHALP9107, 300 - 1000 MHz	91071205	9907	12 months
Antenna Mast System, Jyske EMC, h = 1 - 5 m	93-90172	NA	NA
Turn Table, Jyske EMC	93-90171	NA	NA
Shielded Chamber, Jyske EMC, 11 x 6 x 4.5 m	93-90168	9703	36 months
Anechoic Chamber, 8 x 4.5 x 3 m	93-87151	9704	36 months
Open Area Test Site for 3 m antenna distance	-	9704	36 months

For emission test at fundamental frequency 6.3 GHz and for emission test 1 to 18 GHz:

Spectrum Analyzer, HP 8566B	2950A06284	0003	12 months
Plotter, HP 7475A	2641L16543	NA	NA
Signal Amplifier, HP 8449B, 1 – 26.5 GHz	FMV	0003	12 months
Double Ridged Guide Antenna, EMCO 3115, 1 - 18 GHz	2338	9709	36 months
Coaxial Cable, Sucoflex 104, l = 5 m	050SU4MV	0001	12 months
Coaxial Cable, W.L.Gore, GD5015010394, l = 1 m	010GO1M4	9905	12 months

For emission test at harmonic frequencies above 18 GHz:

Spectrum Analyzer, HP 8566B	2950A06284	0003	12 months
Plotter, HP 7475A	2641L16543	NA	NA
Signal Mixer, HP 11970K, 18 - 26.5 GHz	UA-004	0003	12 months
Signal Mixer, HP 11970A, 26.5 - 40 GHz	UA-005	0003	12 months
Mixer Amplifier, HP 11975A, 2 - 8 GHz	FO-003	9905	12 months
Standard Gain Horn Antenna, Microguide AN180-DR, 18 - 40 GHz.	AT-001	0003	36 months
Adapter coaxial to waveguide, Midisco 18 – 40 GHz	DA-001	0003	36 months
Coaxial Cable, W.L.Gore, GD5015010394, l = 1 m	010GO1M4	9905	12 months
0 – 40 GHz, from antenna to mixer			

TEST SET-UP AND PROCEDURE:

See Appendix 1 and 2. As laid out in ANSI C.63.4:1992 Document.

TEST CONDITIONS:

Rating: 115 VAC, 60 Hz, to the peripheral Power Supply. 24 VDC 60 mW to the Tank Radar.

Peripherals: AC/DC Power Supply, Trio PR-630, 115 VAC / 24 VDC. Class I.

Power Line Filter: See Appendix 3.

Cables: Unshielded combined power line and signal cable of 1 m length without protective earth. Unshielded mains cable of 2.5 m length to the Power Supply.

Clock Frequency: 1.843 MHz. Radar center frequency 6.3 GHz.

Effective radiated power: Less than 0.1 mW.

Radar Pulse data: Pulse length 1.2 nanosecond. Repetition frequency 1 MHz. See Appendix 4.

Modulation type: No modulation.

Modifications: No modifications.

Operating Conditions: Normal operating conditions. Active level gauging with level measurements. The EUT was programmed for 20 m measurement distance and for the Antenna types used during the tests. Tested at 115 VAC to the Power Supply, and within the range 18 to 36 VDC to the EUT.

TEST PERFORMANCE:

1. § 15.107 and 2. § 15.207: Conducted Emission test.

The conducted emission was measured on the Power input terminals (115 V) to the Power Supply through a 50 ohm 50 micro-Henry LISN (Line Impedance Stabilization Network) in the frequency range 0.45 to 30 MHz. The neutral line and the phase line were measured with a quasi-peak detector. See Appendix 5 and 6.

1. § 15.109 and 2. § 15.209: Radiated Electromagnetic Field (9 kHz - 1000 MHz).

Pre-test:

Pre-test was performed in the Anechoic chamber at a distance of 3 m. The EUT was measured in x-y-z-directions and rotated to find any emission. The antenna polarization was both vertical and horizontal during the test. In the range 9 kHz – 30 MHz is the limit pointed out at an antenna distance of 300 m and 30 m. The limit at 3 m distance and at 9 kHz was calculated by using the square of an inverse linear distance extrapolation factor of 40 dB/decade. $L = L1 + 40 \times \log(D1/D)$. The limit was then calculated as: Limit (dB μ V/m @ 3 m) = 48.5 + 40 x log2400/f (kHz). A loop antenna was used in this frequency range. The antenna factor for electrical field was then used for calculation of the field strength in dB μ V/m. See Appendix 7 (9 kHz – 30 MHz) and Appendix 8 to 11 (30 – 1000 MHz).

Final Test:

No final test was performed. The result from the pre-test show no measurable emissions at all.

1. § 15.109 and 2. § 15.209: Radiated Electromagnetic Field (1 - 40 GHz):

Measured in the frequency range 1 - 40 GHz on the open area test site. The emission was maximized by rotating the table, varying the antenna height 1 to 4 m and the antenna polarization in vertical or horizontal positions. Test instruments according to "TEST EQUIPMENT"- list on page 2 and 3. Test equipment set-up as in Appendix 12.

TEST PERFORMANCE (CONTINUED):

Measurements on the fundamental, 6.22 GHz: Antenna distance of 3 m. The analyzer was in max. hold with average detector (RBW = 1 MHz, VBW = 10 kHz). The maximum amplitude was found at 6.22 GHz. The emission of the fixed frequency was maximized by rotating the table, varying the antenna height and the antenna polarization. Then was the emission measured with average detector and also with peak detector (RBW = 1 MHz, VBW = 1 MHz).

See Appendix 13 to 20 for the 4 different antennas. The limit at 3 m distance is with average detector 54 dBuV/m (500 μ V/m) and with peak detector 74 dBuV/m (same limit for Subpart B Class B, § 15.109, and for Subpart C, § 15.209).

Measurements on the harmonics: Harmonics: 12.44, 18.68, 24.88, 31.1 and 37.32 GHz. Measured up to 38.5 GHz. Measurement at 3 m distance was not possible because the harmonics were too low. The distance was changed to 0.3 m and the limit linearly converted to this distance by adding 20 dB. The peak limit is at 3 m 20 dB + AV. limit = 74 dBuV/m. At 0.3 m is the peak limit then 74 dB μ V/m plus 20 dB = 94 dBuV/m. The AV. limit is at 0.3 m 74 dB μ V/m. The antenna was faced direct against the EUT antenna opening to receive maximum signal. Tested with vertical and horizontal antenna polarization's. No emissions were observed. The whole frequency range was also swept to find all possible emission from the EUT. The noise level in the measuring system was more than 20 dB below the AV. limit.

SUMMARY OF RESULTS:

No influence of different input voltage in the range 18 to 36 VDC.

Emission in the frequency range 9 kHz to 1000 MHz:

§ 15.107 and § 15.207:

The conducted emission margin to limit was - 9.3 dB (QP) at 9.2 MHz. See Appendix 5 and 6.

§ 15.109 and § 15.209:

The radiated emission margin to limit was more than - 10 dB (Peak) in the whole frequency range. See diagram in Appendix 7 to 11 and calculation in Appendix 12.

Emission in the frequency range 1 to 40 GHz:

Fundamental: Margin to limit (Class B) was with average detector - 15.5 dB and with peak detector - 2.0 dB as worst case (8" Antenna).

Harmonics: Margin to limit (Class B) were with average detector more than - 20 dB and with peak detector more than - 30 dB (noise level).

The Radar Level Gauge, Model Saab Loopradar, s/n 010, did pass the above mentioned tests in Part 15, Subpart B, Digital Devices Class B, and Subpart C, Field Disturbance Sensor.

Karlskrona March 28, 2000



Hans Östergren
Manager Svenska EMC Lab AB



Bo Gidlöw
Test Engineer

List over Appendixes.

<u>Appendix No</u>	<u>Note</u>
1	Test set-up, photos
2	Test set-up, photos
3	Power line filter
4	Radar pulse data
5	CE, 0.45 - 30 MHz, live
6	CE, 0.45 - 30 MHz, neutral
7	RE, 9 kHz – 30 MHz
8	RE, 30 - 300 MHz, VP, 3 m, 8” Antenna
9	RE, 30 - 300 MHz, HP, 3 m, 8” Antenna
10	RE, 300 - 1000 MHz, VP, 3 m, 8” Antenna
11	RE, 300 - 1000 MHz, HP, 3 m, 8” Antenna
12	Calculation of radiated emission
13	Test equipment set-up
14 - 21	Fundamental, 6.22 GHz. All Antennas
22 - 28	Harmonic, 12.44 GHz. All Antennas
29	Calculation of Final Emission Levels, 1 - 40 GHz

Radiated Fieldstrength Test. Calculation of Final Emission Levels

EUT: Radar Level Gauge. Model Saab Loopradar, s/n 010.

Test spec.: 47 Cfr Ch. 1 (10-1-99 Edition), Part 15:
 - Subpart B, Class B.
 - Subpart C, Field Disturbance Sensor.
 Radiated emission, Open Area Test Site
 3 m antenna distance.

Date: March 14 - 15, 2000

Operation: Normal operating conditions

Field strength (dBuV/m) = Amplitude (dBuV) + Antenna factor (dB/m) + cable loss (dB)

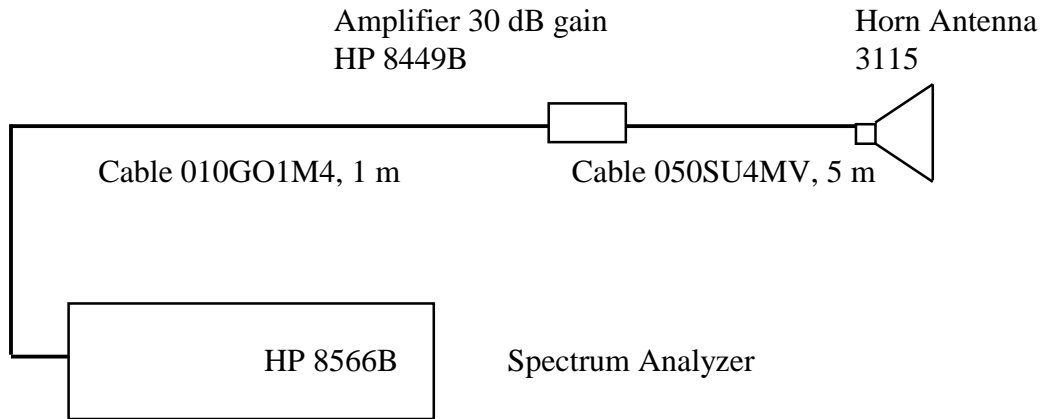
Tested frequency range: 30 - 1000 MHz

Measured quasi-peak values.

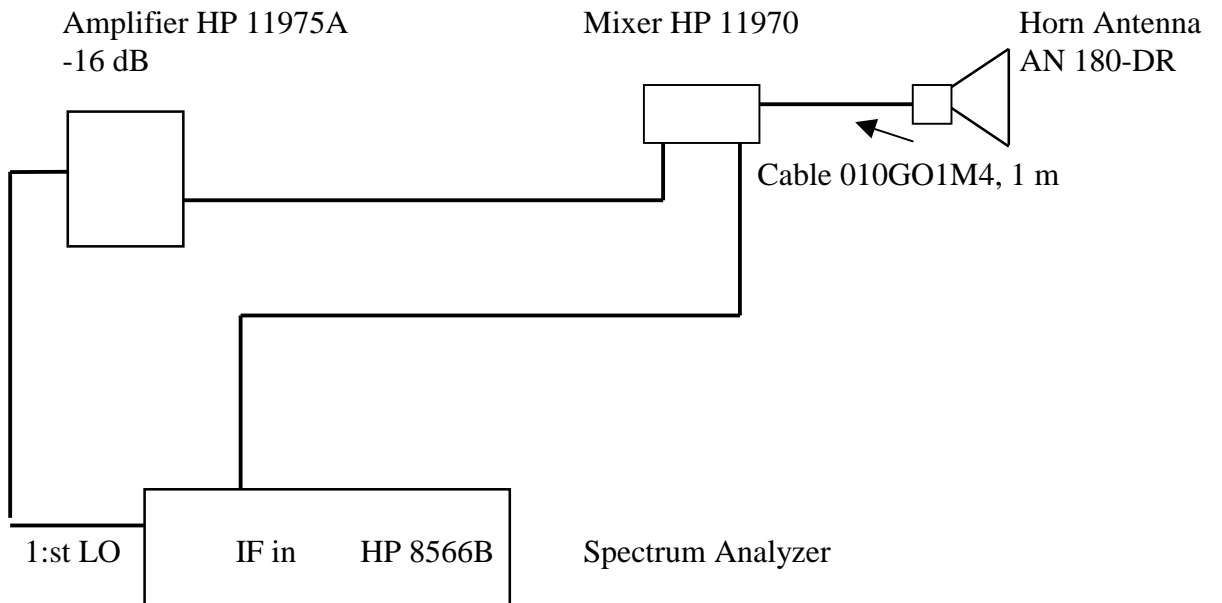
Freq.	App.	Ampl	Cable loss	Ant fact	Field streng.	Limit	Dist	Mar- gin	Ant. height	Ant. pola r
MHz	No	dBuV	dB	dB/m	dBuV/m	dBuV/m	m	dB	m	v/h
33.18	12	13.9	1.3	17.7	32.9		3	- 6.1	1.0	v
44.24	12	15.6	1.6	13.7	30.9		3	- 8.1	1.0	v
196.60	12	16.9	3.8	16.5	37.2		3	- 6.2	1.0	v
233.47	12	17.5	4.1	17.3	38.9		3	- 7.5	3.2	h
239.61	12	16.4	4.2	17.4	38.0		3	- 8.4	2.2	h
245.76	12	21.8	4.2	17.5	43.5		3	- 2.9	2.6	v
307.20	12	16.5	4.6	16.1	37.2		3	- 9.2	3.6	h
344.06	12	19.0	5.0	16.3	40.3		3	- 6.1	3.1	h

Test equipment set-up

1 - 18 GHz:



18 - 40 GHz:



Radiated Fieldstrength Test. Calculation of Final Emission Levels

EUT: Radar Level Gauge. Model Saab Loopradar, s/n 010.

Test spec.: 47 Cfr Ch. 1 (10-1-99 Edition):
 Part 15, Subpart C, Field Disturbance Sensor.
 Radiated emission, Open Area Test Site
 3 m and 0.3 m antenna distance.

Date: March 14 - 15, 2000

Operation: Normal operating conditions

Field strength (dBuV/m) = Amplitude (dBuV) + Antenna factor (dB/m) + cable loss (dB) + Gain (dB)

Tested frequency range: 1 - 40 GHz

Measured maximum peak and average values.

Freq.	Antenna type	Amplitude peak / av.	RBW / VBW	Antenna factor	Preamp gain	Cable loss C1	Cable loss C2	Field strength	Dist	Limit (1-40 GHz)	Margin to limit	Note
GHz		dBμV	kHz / kHz	dB/m	dB	dB	dB	dBμV/m	m	dBμV/m	dB	
6.22	8"	53.1 / -	1000/1000	35.3	- 34.5	3.5	1.1	58.5	3	74	- 15.5	peak
6.22	8"	- / 46.6	1000 / 10	35.3	- 34.5	3.5	1.1	52.0	3	54	- 2.0	av.
6.22	6"	51.6 / -	1000/1000	35.3	- 34.5	3.5	1.1	57.0	3	74	- 17.0	peak
6.22	6"	- / 44.2	1000 / 10	35.3	- 34.5	3.5	1.1	49.6	3	54	- 4.4	av.
6.22	4"	49.3 / -	1000/1000	35.3	- 34.5	3.5	1.1	54.7	3	74	- 19.3	peak
6.22	4"	- / 42.4	1000 / 10	35.3	- 34.5	3.5	1.1	47.8	3	54	- 6.2	av.
6.22	Rod	50.0 / -	1000/1000	35.3	- 34.5	3.5	1.1	55.4	3	74	- 18.6	peak
6.22	Rod	- / 43.0	1000 / 10	35.3	- 34.5	3.5	1.1	48.4	3	54	- 5.6	av.
12.44	8"	25* / -	10 / 10	39.7	- 33.0	5.2	1.5	38.4*	0.3	94	- 55.6	peak
12.44	8"	- / 39*	3000 / 10	39.7	- 33.0	5.2	1.5	52.4*	0.3	74	- 21.6	av.
12.44	6"	25* / -	10 / 10	39.7	- 33.0	5.2	1.5	38.4*	0.3	94	- 55.6	peak
12.44	6"	- / 36*	1000 / 10	39.7	- 33.0	5.2	1.5	49.4*	0.3	74	- 24.6	av.
12.44	4"	46* / -	1000/1000	39.7	- 33.0	5.2	1.5	59.4*	0.3	94	- 34.6	peak
12.44	4"	- / 36*	1000 / 10	39.7	- 33.0	5.2	1.5	49.4*	0.3	74	- 24.6	av.
12.44	Rod	25* / -	10 / 10	39.7	- 33.0	5.2	1.5	38.4*	0.3	94	- 55.6	peak
18.66	All	< 18* / -	10 / 10	32.6	-	-	1.9	< 52.5*	0.3	94	- 41	peak
24.88	All	< 15* / -	10 / 10	33.8	-	-	2.3	< 51.1*	0.3	94	- 43	peak
31.10	All	< 18* / -	10 / 10	34.9	-	-	2.5	< 55.4*	0.3	94	- 38	peak
37.32	All	< 16* / -	10 / 10	36.6	-	-	2.9	< 55.5*	0.3	94	- 38	peak

* = Noise level